Power Coupler for the European X-ray laser project X-FEL

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X-FEL coupler meeting, Nov. 25th - 26th, 2003

1. Coupler specification
2. Coupler produced & operated for TTF
3. Agenda for this meeting

1. Coupler specification

frequency	1.3 GHz
operation	pulsed: 500 µsec risetime, 800 µsec flat top with beam
two windows	• safe operation • clean cavity assembly for high gradients
2 K heat load	0.06 W
4 K heat load	0.5 W
70 K heat load	6 W
isolated inner conductor	bias voltage, suppressing multipacting
diagnostic	sufficient for safe operation and monitoring

1. Coupler specification, cont'd

	TTF	**TESLA 9-cell / upgrade**	**TESLA superstructure / upgrade**	**TESLA X-FEL Supplement**
peak power + control margin (27%)	250 kW	250 kW / 500 kW	555 kW / 1110 kW	150 kW
repetition rate	10 Hz	5 Hz	5 Hz	10 Hz
average power	3.2 kW	3.2 / 6.4 kW	3.6 / 7.2 kW	1.9 kW
coupling (Qext)	adjustable (10^6 - 10^7)	fix ($3*10^6$)	fix ($2.5*10^6$)	not decided ($4.6*10^6$)
cavity position during cool down	flexible (15 mm longitudinal)	fix point (1.5 mm longitudinal)	fix point (1.5 mm longitudinal)	fix point (1.5 mm longitudinal)

Coupler specification for the European X-ray laser project XFEL, cont'd

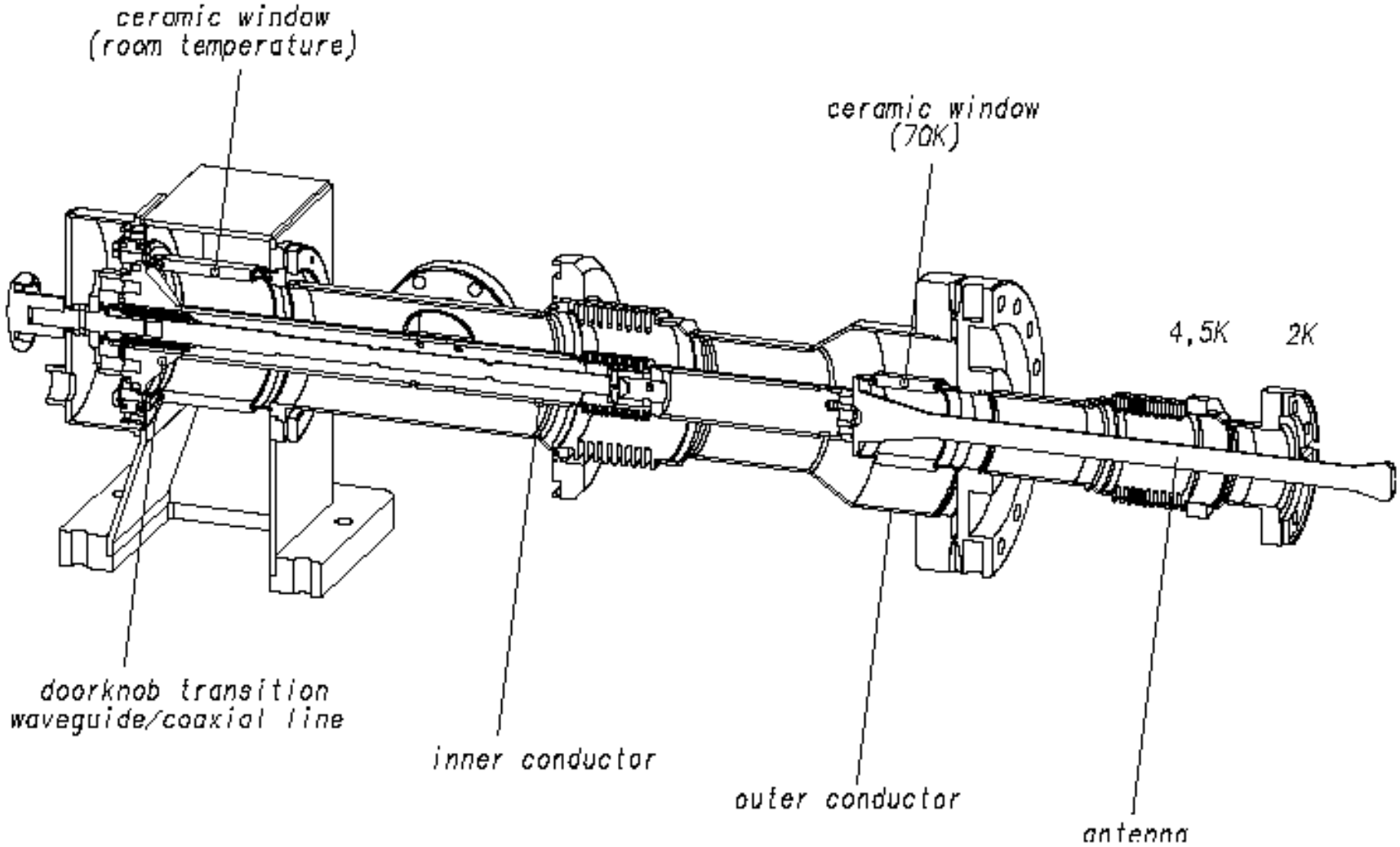
peak power + control margin (27%)	≤ 150 kW
repetition rate	10 Hz
average power	≤ 1.9 kW
coupling (Qext)	not decided ($2*10^6$ - $7.5*10^7$)
cavity position during cool down	fix point (1.5 mm longitudinal)

2. TESLA power couplers

Coupler type		FNAL	TTF I	TTF II	TTF III	TTF IV	Saclay/Orsay
cold part	window	conical	cyl.	cyl.	cyl.	cyl.	disk
	coax diameter, mm	40	40	40	40	80	80
	Impedance, Ohm	50	50	70	70	70	50
warm part	window	planar, WG	cyl.	planar, WG	cyl.	cyl.	planar, WG
	coax diameter, mm	60	40	60	60	80	80
	Impedance, Ohm	50	50	50	50	50	50
coupling		adjustible	adjustible	adjustible	adjustible	fix	fix
bias		no	no	yes	yes	yes	
TiN coating		F	F	F	D	D	
test stand	2Hz / 500µs	1MW	1MW	2MW	1MW		
	2Hz / 1.3ms	1MW	1MW	1.8MW (1)	1MW		
TW	cold test done	yes	yes	no	no		
horiz. test	2Hz / 500µs	1MW	1MW	1MW	1MW		
	10Hz / 1.3ms	33MV/m	25MV/m	35MV/m	35MV/m		
SW	cold test done	yes	yes	yes	yes		
fabricated total		13	4	20	22 (40)	2	
assembled to		Mod.1*, 2	Mod.1	Mod.1*, 3, 4	Mod.5, SS(6-8)		
operated		2 years	1 year	2 years	11: 2 month		

last version

TTF 3 Coupler



Reasons for this meeting

1. everybody feels that the processing time is to long and
2. prize is to high

   – but we know that the existing TTF III coupler design is able to handle the necessary power for the X-FEL

   – we have no operating experience with the TTFIII coupler yet

Long processing time

- is it really to long compared to other coupler designs?

- what is determine the processing time?
  - residual gases
  - pumping speed
  - multipacting / secondary electron emission coefficient
  - conditioning procedure

Tuesday, Nov. 25th, before noon

Processing experience with existing designs

2	9:20	X-FEL Linac Parameters	R. Brinkmann	15	15
3	9:50	TTF 3 Coupler test & operating results	D. Kostin	40	20
	10:50	**Coffee**		30	
		Processing time			
4	11:20	Coupler processing times at other labs	P. Lepercq	20	20
5	12:00	Residual gas analysis during processing at the TTF3 coupler and other labs	D. Kostin	20	20
	12:40	**Lunch**		90	

Tuesday, Nov. 25th, afternoon

Vacuum related issues

		Vacuum			
6	14:10	Effect of baking on high vacuum components	M. Seidel	20	20
7	14:50	Influence of different gas layers on the second. electron emission coefficient	D. Kostin	20	20
	15:30	**Coffee**		30	
8	16:00	Pumping limitations of the TTF3 coupler and its vacuum connections	J. Wojtkiewicz	15	10
9	16:25	Limitations for the in situ baking of the coupler in the existing module design	HERA-B	15	20
10	17:00	Cold window vs. warm window from mech. design viewpoint	C. Martens	15	20
	17:35	**End**			

How to reduce the prize

- optimization of the mass production (not a topic this time)

- eliminate the variable coupling
  - less bellows
  - less mechanical parts
  - no remote operation (motor, power supply, cabling)

Wednesday, Nov. 26th, before noon

Variable or fixed coupling

		Qext			
11	9:00	Field enhancement in the coupler due to change of Qext with a three-stub-tuner for the different X-FEL operating conditions	A. Labance	30	20
12	9:50	Limitations / performance of the existing tree stub tuner	V. Katalev S. Choroba	15	15
		coax diameter 40 vs. 60 mm			
13	10:20	Multipacting calculations and measurements on coupler tests	D. Kostin	15	15
	10:50	**Coffee**		30	
14	11:20	Commissioning of modules on test stand or in tunnel	W.-D. Moeller	15	15
	11:50	**Lunch**		90	

Wednesday, Nov. 26th, afternoon

open for discussion
making decisions

	13:30	brain storming on other coupler ideas	Garvey/Moeller		60
	14:30	Discussion decisions and conclusions	Garvey/Moeller		60
	15:30	**Coffee**			30
	16:00	preparing a recommendation	Garvey/Moeller		60
	17:00	**Concluding remarks**	Moeller		

we have to answer following questions:

1. Do we need a new coupler design?
2. If yes, how should the new coupler look like?
3. Is only a modification of the TTF3 coupler necessary?
4. If yes, what has to be changed?
5. What is the impact of the module design?
6. What are the time and manpower needed?

We will prepare a written recommendation on this issues